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cont

138. (Twice amended) The imaging system according to claim 123, wherein said gate stack comprises a transfer gate stack and a reset gate stack.

Sub H5

140. (Amended) The imaging device according to claim 135, wherein said nitrogen containing insulating layer is disposed over a portion of said transfer gate stack.

Sub
I1

141. (Amended) The imaging device according to claim 136, wherein said nitrogen containing insulating layer is disposed over a portion of said transfer gate stack.

142. (Amended) The imaging system according to claim 137, wherein said nitrogen containing insulating layer is disposed over a portion of said transfer gate stack.

143. (Amended) The imaging system according to claim 138, wherein said nitrogen containing insulating layer is disposed over a portion of said transfer gate stack.

144. (Amended) The imaging device according to claim 139, wherein said nitrogen containing insulating layer is disposed over a portion of said transfer gate stack.

REMARKS

Reconsideration and allowance of this application, as amended, are respectfully requested. Claims 1, 14, 28, 34-39, 47-53, 117, 118, 122, 123, 127, 128, 132, 133, 137, 138, and 140-144 have been amended; claim 145 has been canceled. Claims 1-4, 7-15, 18-23, 25-29, 31-39, 41-63, 65, 66, and 115-144 are now pending in the application. The rejections are respectfully submitted to be obviated in view of the amendments and remarks presented herein.

In the present Amendment, claims 140-144 have been amended in response to the rejection under § 112, first paragraph. Claims 34-38, 47-52, 117, 118, 122, 123, 127, 128, 132, 133, 137, and 138 have been amended in response to the rejection under § 112, second paragraph.

Claims 1, 14, 28, 39, and 53 have been amended to recite that the nitrogen containing insulating layer is in contact with the substrate. Support for the recitation is found at specification page 17, lines 1-2, and in drawing Figs. 8-10.

Entry of each of the above amendments is respectfully requested.

35 U.S.C. § 112, First Paragraph

Turning to the Office Action, claim 66 remains rejected under 35 U.S.C. § 112, first paragraph. The Office Action asserts that “[t]he ‘processor’ (claim 53) for particular use in a ‘camera’ is unclear from the specification (page 19).”

As explained in Applicant’s response filed May 29, 2001, Applicant respectfully submits that the meaning of the claimed “processor” (claim 53) for use in a “camera” (claim 66) would be evident to any person skilled in the art from the context of the disclosure at specification page 18, line 28, through page 19, line 21. Applicant discloses that “[t]he illustrated system is exemplary of a device having digital circuits which include CMOS imager devices,” and that “[o]ther types of processor systems which include the same or similar systems of FIG. 11 include cameras, scanners, machine vision systems . . .”

Applicant submits that it would be abundantly clear to any person skilled in the art that the “processor” required for use in the claimed camera is a means for executing instructions, or programs having instructions, often known as a central processing unit (CPU), or often simply described as a “processor.” Secondly, the meaning of a processor for use in a camera would be clear from the background disclosure at specification page 4, line 26, through page 5, line 3, where Applicant discloses, for example, the description in Nixon et al., “256 x 256 CMOS Active Pixel Sensor Camera-on-a-Chip,” IEEE Journal of Solid-State Circuits, Vol. 31(12) pp. 2046-2050, 1996.

Reconsideration and withdrawal, therefore, of the rejection of claim 66 under § 112, first paragraph, are respectfully requested.

35 U.S.C. § 102 – Anagnostopoulos

Claims 1-4 and 7-13 stand rejected under 35 U.S.C. § 102 as allegedly being anticipated by U.S. Patent No. 5,804,845 to Anagnostopoulos et al. (hereinafter “Anagnostopoulos”).

The rejection is respectfully deemed to be obviated in view of the amendment of claim 1. For at least the following reasons, the disclosure of Anagnostopoulos does not identically describe Applicant’s claimed invention, as is required to support a § 102 rejection.

The Office Action relies upon Figs. 2A, 3B, and 3C of Anagnostopoulos. The cited reference does not identically describe Applicant’s claimed invention because it fails to disclose the claimed “nitrogen containing insulating layer in contact with said substrate and

beneath said photogate” (emphasis added). In Anagnostopoulos (e.g., Fig. 3B), it is the oxide layer 43 which is in contact with the substrate, i.e., the nitride layer is separated from the substrate by oxide layer 43. Even the prior art disclosed in Anagnostopoulos (Fig. 3C) discloses SiO₂ layer 52 between the substrate and the nitride layer 51.

Anagnostopoulos, therefore, fails to identically describe Applicant’s claimed invention.

For at least the above reasons, reconsideration and withdrawal of the rejection of claims 1-4 and 7-13 under § 102 are respectfully requested.

35 U.S.C. § 103 – Anagnostopoulos

Claims 53-63, 65, and 66 stand rejected under 35 U.S.C. § 103 as allegedly being unpatentable over Anagnostopoulos. For at least the reasons identified above with respect to the rejection under § 102, the rejection is respectfully traversed.

The rejected claims define a system that includes the imaging device defined in amended claim 1. As indicated above, Anagnostopoulos does not identically describe Applicant’s claimed invention because it fails to disclose the claimed “nitrogen containing insulating layer in contact with said substrate and beneath said photogate.” Therefore, regardless of the Office Action’s assertion that it would have been obvious to use the image sensors of Anagnostopoulos with Applicant’s claimed processor, the asserted combination of elements does not result in the claimed invention.

For at least the above reasons, reconsideration and withdrawal of the rejection of claims 53-63, 65, and 66 under § 103 are respectfully rejected.

35 U.S.C. § 103 – “Acknowledged Prior Art” and Nagasaki

Claims 1-3, 7, 12, 14, 15, 18, 19, 25, 26, 28, 29, 31-33, 38, 39, 41, 44, 46, 51, 53-55, 57-59, 66, 115-124, and 135-139 stand rejected under 35 U.S.C. § 103 as allegedly being unpatentable over “the acknowledged prior art in this application (Figures 1, 2, pages 1-12) and Nagasaki et al., considered together.”

The rejection is respectfully traversed. The combined disclosures would not have rendered obvious the embodiments of the invention defined by any of the rejected claims.

The claimed invention would have been unobvious because there is no suggestion or motivation, either in the references or in the knowledge generally available to one of ordinary skill in the art, to combine the reference teachings.

With regard to Applicant’s claim 1, the asserted combination fails to suggest Applicant’s claimed imaging device comprising a “nitrogen containing insulating layer in contact with said substrate and beneath said photogate.”

It is respectfully submitted that the disclosure of Nagasaki cannot compensate for the deficiency of “the acknowledged prior art.” Nagasaki discloses a solid-state imaging device containing an insulating film made of “a high dielectric material having a *high* relative dielectric constant” (column 11, lines 20-22)(emphasis added). The Office Action suggests that from Nagasaki (Figure 17; columns 2-3) it would have been obvious to use

an insulator with a higher dielectric constant in order to increase the capacity of the photogate.

However, while Nagasaki teaches the use of a high dielectric material, it also specifically teaches that silicon oxide and silicone nitride are *low* dielectric constant materials, while antiferroelectrics and ferroelectrics are high dielectric materials (column 3, lines 20-28). Nagasaki then proceeds to unequivocally and repeatedly exclude the use of low dielectric materials, including silicone oxide and silicone nitride, in its invention (column 4, line 57; column 5, line 42; column 6, line 33; column 6, lines 57-59; etc.)

As established above, by teaching the use of a material having a *high* relative dielectric constant, Nagasaki clearly teaches away from using nitrogen containing insulating materials. Nagasaki thus teaches away from Applicant's claimed invention. From the teaching of Nagasaki, therefore, it is not plausible to suggest that one of ordinary skill in the art would have used Applicant's claimed nitrogen containing material in place of a silicon oxide.

The Office Action asserts that it would have been obvious to use an insulator with a higher dielectric constant to increase the capacity of the photogate. No reference is cited, however, which suggests the use of a nitrogen containing insulating layer in the location claimed. Nagasaki does not teach or suggest that a nitrogen containing insulating layer would be useful for any purpose in the location claimed, much less to achieve the improved signal acquisition, wider dynamic range, and improved signal to noise ratio

discussed, for example, at page 13, lines 10-20, and page 18, lines 20-24, of the specification.

Nagasaki *teaches* the use of “a high dielectric material having a *high* relative dielectric constant” (column 1, lines 65-66). In Table 1 (column 3), Nagasaki discloses that “SiO₂” is a “low dielectric material” with a relative dielectric constant of 4.5, and that “Si₃N₄” is a “low dielectric material” with a relative dielectric constant of 10. Every other entry in Table 1, none of which includes nitrogen, is described as a “high dielectric material.”

Therefore, simply because Si₃N₄ has a higher relative dielectric constant than SiO₂ does not mean that the nitrogen containing Si₃N₄ would be acceptable to Nagasaki. Nagasaki teaches the use of “a high dielectric material having a *high* relative dielectric constant,” and the only nitrogen containing material in Table 1, Si₃N₄, is described by Nagasaki as being “a *low* dielectric material.”

Thus, the asserted combination would not have rendered obvious the various embodiments of the invention defined by any of Applicant’s rejected independent claims. The rejected dependent claims are allowable along with the aforementioned independent claims, and on their own merits.

Claim 14 recites an “imaging device including a semiconductor integrated circuit substrate . . . comprising . . . a nitrogen containing insulating material in contact with said substrate and beneath said photogate.” Applicant submits that claim 14 is allowable for the same reasons outlined above for allowance of claim 1.

Claims 15, 18, 19, 25, 26, and 116 are dependent upon claim 14, and contain all the limitations of claim 14. Claims 15, 18, 19, 25, 26, and 116 are believed to be in immediate condition for allowance for those reasons outlined above for the allowance of claim 14, and also because the unique combinations recited in these dependent claims are neither taught nor suggested by the cited combination of references.

Claim 28 recites “an imaging system comprising . . . wherein a nitrogen containing insulating layer is in contact with said substrate and beneath said photogate.” Applicant submits that claim 28 is allowable for the same reasons outlined above for allowance of claim 1.

Claims 29, 31-33, 38, and 117 are dependent upon claim 28, and contain all the limitations of claim 28. Claims 29, 31-33, 38, and 117 are believed to be in immediate condition for allowance for those reasons outlined above for the allowance of claim 28, and also because the unique combinations recited in these dependent claims are neither taught nor suggested by the cited combination of references.

Claim 39 recites “an imaging system . . . wherein a nitrogen containing insulating layer is in contact with said substrate and beneath said photogate.” Applicant submits that claim 39 is allowable for the same reasons outlined above for allowance of claim 1.

Claims 41-44, 51, and 118 are dependent upon claim 39, and contain all the limitations of claim 39. Claims 41-44, 51, and 118 are believed to be in immediate condition for allowance for those reasons outlined above for the allowance of claim 39, and

also because the unique combinations recited in these dependent claims are neither taught nor suggested by the cited combination of references.

Claim 53 recites a “system comprising . . . a CMOS imaging device . . . including . . . a nitrogen containing insulating layer in contact with said substrate and beneath said photogate.” Applicant submits that claim 53 is allowable for the same reasons outlined above for allowance of claim 1.

Claims 54-55, 57-59, and 119 are dependent upon claim 53, and contain all the limitations of claim 53. Claims 54-55, 57-59, and 119 are believed to be in immediate condition for allowance for those reasons outlined above for the allowance of claim 53, and also because the unique combinations recited in these dependent claims are neither taught nor suggested by the cited combination of references.

For at least the above reasons, reconsideration and withdrawal of the rejection of claims 1-3, 7, 12, 14, 15, 18, 19, 25, 26, 28, 29, 31-33, 38, 39, 41, 44, 46, 51, 53-55, 57-59, 66, and 115-119 under § 103 are respectfully rejected.

35 U.S.C. § 103 – “Acknowledged Prior Art” and Nagasaki, with Koike

Claims 4, 27, 45, 56, 125-134 and 140-144 stand rejected under 35 U.S.C. § 103 as allegedly being unpatentable over “the acknowledged prior art in this application (Figures 1, 2, pages 1-12) and Nagasaki et al., further considered together with Koike et al.”

The rejection is respectfully traversed. The combined disclosures would not have rendered obvious the embodiments of the invention defined by any of the rejected claims.

For all of the reasons identified above with respect to the rejection over the acknowledged prior art and Nagasaki, the claimed invention would have been unobvious because there is no suggestion or motivation, either in the references or in the knowledge generally available to one of ordinary skill in the art, to combine the reference teachings.

Furthermore, it is respectfully submitted that the disclosure of Koike cannot compensate for the above-described deficiency of Nagasaki. The independent claims from which claims 4, 27, 45, 56, and 120-129 depend recite a nitrogen containing insulating layer in contact with the substrate and beneath the photogate. Koike does not even suggest a nitrogen containing insulating layer. For this reason alone, claims 4, 27, 45, 56, and 120-129 are allowable over the asserted combination.

Additionally, claims 4, 27, 45, 56 recite a “semi-transparent conductor ... selected from the group consisting of indium-tin-oxide, tin oxide, indium oxide and doped hydrogenated amorphous silicon.” Koike in column 3 discloses “a material permitting light to permeate ... made of SnO_2 [tin-dioxide] or InO_2 [indium-dioxide] or a semi-transparent electrode made of polycrystalline silicon.” Therefore, Koike does not disclose the use of indium-tin-oxide, tin-oxide, indium oxide or doped hydrogenated amorphous silicon.

Further, because Koike does not remedy Nagasaki’s deficiency associated with the use of silicon nitride or other nitrogen containing insulating material, it cannot be construed as also teaching any of the structural configurations set forth in claims 120-129. Claims 120-129 recite a “gate stack over [a] substrate and beneath [a nitrogen containing]

insulating layer.” Nagasaki does not teach an insulating layer over any structure that can be comparable to a gate stack.

For at least the above reasons, reconsideration and withdrawal of the rejection of claims 4, 27, 45, 56, 125-134 and 140-144 under § 103 are respectfully rejected.

35 U.S.C. § 103 – “Acknowledged Prior Art” and Nagasaki, with Suzuki

Claims 8, 10, 11, 20, 22, 23, 34, 36, 37, 47, 49, 50, 60, 62 and 63 stand rejected under 35 U.S.C. § 103 as allegedly being unpatentable over the acknowledged prior art (Figures 1, 2, pages 1-12) and Nagasaki, further considered together with Suzuki.

The rejection is respectfully traversed. The combined disclosures would not have rendered obvious the embodiments of the invention defined by any of the rejected claims.

For all of the reasons identified above with respect to the rejection over the acknowledged prior art and Nagasaki, the claimed invention would have been unobvious because there is no suggestion or motivation, either in the references or in the knowledge generally available to one of ordinary skill in the art, to combine the reference teachings.

Furthermore, it is respectfully submitted that the disclosure of Suzuki cannot compensate for the above-described deficiency of Nagasaki. The independent claims from which claims 8, 10, 11, 20, 22, 23, 34, 36, 37, 47, 49, 50, 60, 62 and 63 depend recite a nitrogen containing insulating layer in contact with the substrate and beneath the photogate. Suzuki does not teach the use of a nitrogen containing insulating layer at the location claimed as opposed to a silicon oxide layer. For this reason alone, claims 8, 10, 11,

20, 22, 23, 34, 36, 37, 47, 49, 50, 60, 62 and 63 are allowable over the asserted combination.

For at least the above reasons, reconsideration and withdrawal of the rejection of claims 8, 10, 11, 20, 22, 23, 34, 36, 37, 47, 49, 50, 60, 62 and 63 under § 103 are respectfully rejected.

35 U.S.C. § 103 – “Acknowledged Prior Art,” Nagasaki, Okada, and Anagnostopoulos

Claims 1-4, 7-15, 18-23, 25-29, 31-39, 41-63, 65, 66, 115-124, and 135-139 stand rejected under 35 U.S.C. § 103 as allegedly being unpatentable over the acknowledged prior art (Figures 1, 2, pages 1-12) and Nagasaki, further considered together with Okada and Anagnostopoulos.

The rejection is respectfully traversed. The combined disclosures would not have rendered obvious the embodiments of the invention defined by any of the rejected claims.

For all of the reasons identified above with respect to the rejection over the acknowledged prior art and Nagasaki, the claimed invention would have been unobvious because there is no suggestion or motivation, either in the references or in the knowledge generally available to one of ordinary skill in the art, to combine the reference teachings.

Furthermore, it is respectfully submitted that the disclosures of Okada and Anagnostopoulos cannot compensate for the above-described deficiency of Nagasaki. Even if Okada teaches ONO, Okada does not teach or suggest the structure claimed. The independent claims from which claims 8, 9, 13, 20, 21, 34, 35, 47, 48, 52, 60, 61 and 65

depend recite a nitrogen containing insulating layer in contact with a substrate and beneath a photogate. Neither Okada nor Anagnostopoulos, however, teaches Applicant's claimed nitrogen containing insulating layer in contact with a substrate and beneath a photogate. For this reason alone, the rejected claims are allowable over the asserted combination.

For at least the above reasons, reconsideration and withdrawal of the rejection of claims 1-4, 7-15, 18-23, 25-29, 31-39, 41-63, 65, 66, 115-124, and 135-139 under § 103 are respectfully rejected.

35 U.S.C. § 103 – “Acknowledged Prior Art,” Nagasaki, Okada, Anagnostopoulos, and Koike

Claims 125-134 and 140-144 stand rejected under 35 U.S.C. § 103 as allegedly being unpatentable over the acknowledged prior art (Figures 1, 2, pages 1-12) Nagasaki, Okada, and Anagnostopoulos, further considered together with Koike.

The rejection is respectfully traversed. For all of the reasons identified above, the claimed invention would have been unobvious because there is no suggestion or motivation, either in the references or in the knowledge generally available to one of ordinary skill in the art, to combine the reference teachings.

It is respectfully submitted that the disclosure of Koike cannot compensate for the above-described deficiencies of the other applied references. Applicant's independent claims from which claims 125-134 and 140-144 depend recite a nitrogen containing insulating layer in contact with the substrate and beneath the photogate. Koike does not even suggest Applicant's claimed nitrogen containing insulating layer configuration.

For at least the above reasons, reconsideration and withdrawal of the rejection of claims 125-134 and 140-144 under § 103 are respectfully rejected.

In view of the above, each of the presently pending claims in this application is believed to be in immediate condition for allowance. Accordingly, the Examiner is respectfully requested to withdraw the outstanding rejection of the claims and to pass this application to issue.

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Respectfully submitted,

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Version With Markings to Show Changes Made

In the Claims:

Please amend the claims as follows:

1. (Amended) An imaging device comprising:

a substrate;

a photosensitive area within said substrate for accumulating photo-generated charge in said area;

a photogate for controlling the accumulation of photo-generated charge in said photosensitive area; and

a nitrogen containing insulating layer [over] in contact with said substrate and beneath said photogate.

14. (Amended) An imaging device including a semiconductor integrated circuit substrate, said imaging device comprising:

a photosensitive device, including a photogate overlying said substrate, for accumulating photo-generated charge in a photosensitive area of said substrate;

a readout circuit comprising at least an output transistor formed in said substrate;

a reset transistor for periodically resetting said node to a predetermined voltage;
and

a nitrogen containing insulating material [formed over] in contact with said substrate and beneath said photogate.

28. (Twice amended) An imaging system comprising:

a plurality of active pixel sensors arranged in an array of rows and columns, each active pixel sensor being operable to generate a voltage at a diffusion node corresponding to detected light intensity by the sensor;

a photogate formed over a charge collection area in a substrate in said pixel sensor[;], wherein a nitrogen containing insulating layer is [formed over] in contact with said substrate and beneath said photogate;

a reset device to periodically reset the voltage of said diffusion node;

a row decoder having a plurality of control lines connected to the sensor array, each control line being connected to activate the sensors in a respective row; and

a plurality of output circuits, each output circuit being connected to the respective sensors in a column, operable to store voltage signals received from the sensors and to provide a sensor output signal.

34. (Amended) The imaging [device] system according to claim 28, wherein said nitrogen containing insulating layer is a nitrogen oxide containing layer.

35. (Amended) The imaging [device] system according to claim 34, wherein said nitrogen containing insulating layer is an ONO layer.

36. (Amended) The imaging [device] system according to claim 34, wherein said nitrogen containing insulating layer is an NO layer.

37. (Amended) The imaging [device] system according to claim 34, wherein said nitrogen containing insulating layer is an ON layer.

38. (Amended) The imaging [device] system according to claim 33, wherein said silicon nitride insulating layer is [deposited by] a chemical vapor deposition deposited layer.

39. (Twice amended) An imaging system comprising:

a plurality of active pixel sensors arranged in an array of rows and columns, each active pixel sensor being operable to generate a voltage at a floating diffusion node corresponding to detected light intensity by the sensor;

a photogate formed over a charge collection area in a substrate in said pixel sensor[;], wherein a nitrogen containing insulating layer is [formed over] in contact with said substrate and beneath said photogate;

a reset device to periodically reset the voltage of said diffusion node;

a row decoder having a plurality of control lines connected to the sensor array, each control line being connected to activate the sensors in a respective row; and

a plurality of output circuits, each output circuit being connected to the respective sensors in a column, operable to store voltage signals received from the sensors and to provide a sensor output signal.

47. (Amended) The imaging [device] system according to claim 39, wherein said nitrogen containing insulating layer is a nitrogen oxide containing layer.

48. (Amended) The imaging [device] system according to claim 47, wherein said nitrogen containing insulating layer is an ONO layer.

49. (Amended) The imaging [device] system according to claim 47, wherein said nitrogen containing insulating layer is an NO layer.

50. (Amended) The imaging [device] system according to claim 47, wherein said nitrogen containing insulating layer is an ON layer.

51. (Amended) The imaging [device] system according to claim 46, wherein said silicon nitride insulating layer is [deposited by] a chemical vapor deposition deposited layer.

52. (Amended) The imaging [device] system according to claim 48, wherein said ONO insulating layer is [deposited by] a chemical vapor deposition deposited layer.

53. (Amended) A system comprising:

(i) a processor for processing image data; and

(ii) a CMOS imaging device for providing image data to said processor and including:

a substrate;

a photosensitive area within said substrate for accumulating photo-generated charge in said area;

a photogate for controlling the accumulation of photo-generated charge in said photosensitive area; and

a nitrogen containing insulating layer [over] in contact with said substrate and beneath said photogate.

117. (Amended) The imaging [device] system according to claim 28, wherein said nitrogen containing layer has been removed wherever it is not covered by said photogate.

118. (Amended) The imaging [device] system according to claim 39, wherein said nitrogen containing layer has been removed wherever it is not covered by said photogate.

122. (Three times amended) The imaging [device] system according to claim 28, further comprising a gate stack over said substrate, wherein said gate stack is disposed over an insulating layer of silicon dioxide [which is] disposed over said substrate.

123. (Three times amended) The imaging [device] system according to claim 39, further comprising a gate stack over said substrate, wherein said gate stack is disposed over an insulating layer of silicon dioxide [which is] disposed over said substrate.

127. (Amended) The imaging [device] system according to claim 117, further comprising a gate stack over said substrate and beneath said insulating layer, wherein said gate stack is disposed over an insulating layer of silicon dioxide [which is] disposed over said substrate.

128. (Amended) The imaging [device] system according to claim 118, further comprising a gate stack over said substrate and beneath said insulating layer, wherein said gate stack is disposed over an insulating layer of silicon dioxide [which is] disposed over said substrate.

132. (Amended) The imaging [device] system according to claim 122 wherein each said photogate and said nitrogen containing insulating layer are only partially disposed over said gate stack.

133. (Amended) The imaging [device] system according to claim 123 wherein each said photogate and said nitrogen containing insulating layer are only partially disposed over said gate stack.

137. (Twice amended) The imaging [device] system according to claim 122, wherein said gate stack comprises a transfer gate stack and a reset gate stack.

138. (Twice amended) The imaging [device] system according to claim 123, wherein said gate stack comprises a transfer gate stack and a reset gate stack.

140. (Amended) The imaging device according to claim 135, wherein said nitrogen containing insulating layer is disposed [only] over [either] a portion of said transfer gate stack [or said reset gate stack].

141. (Amended) The imaging device according to claim 136, wherein said nitrogen containing insulating layer is disposed [only] over [either] a portion of said transfer gate stack [or said reset gate stack].

142. (Amended) The imaging [device] system according to claim 137, wherein said nitrogen containing insulating layer is disposed [only] over a portion of [either] said transfer gate stack [or said reset gate stack].

143. (Amended) The imaging [device] system according to claim 138, wherein said nitrogen containing insulating layer is disposed [only] over a portion of [either] said transfer gate stack [or said reset gate stack].

144. (Amended) The imaging device according to claim 139, wherein said nitrogen containing insulating layer is disposed [only] over a portion of [either] said transfer gate stack [or said reset gate stack].